



The Development and Testing of an Oxide Reduction Voltammetry Sensor

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Changing the World's Energy Future

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Introduction

- The electrochemical process (i.e. pyroprocessing) was developed to treat metallic fuels; however, with the addition of an oxide reduction (OR) step, commercial oxide fuels can also be treated electrochemically, see Fig. 1
- Typically, the alkali and alkaline earth metals, as well as group 16 and 17 fission products will chemically dissolve into the molten LiCl-Li₂O salt
- A process monitoring (PM) approach is necessary for timely detection of misuse or undeclared activities in the OR system
- Therefore, a voltammetry sensor was developed and tested

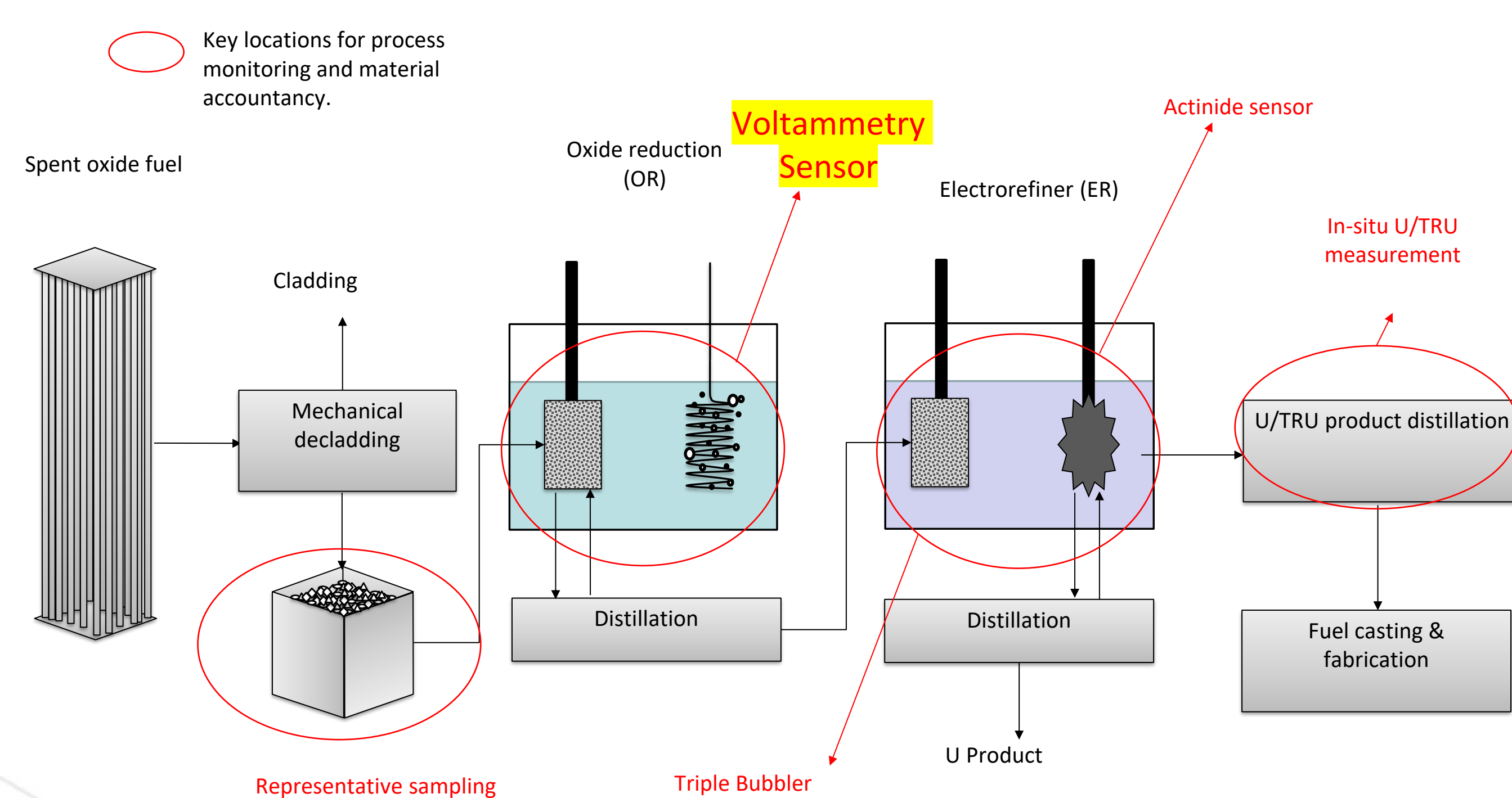
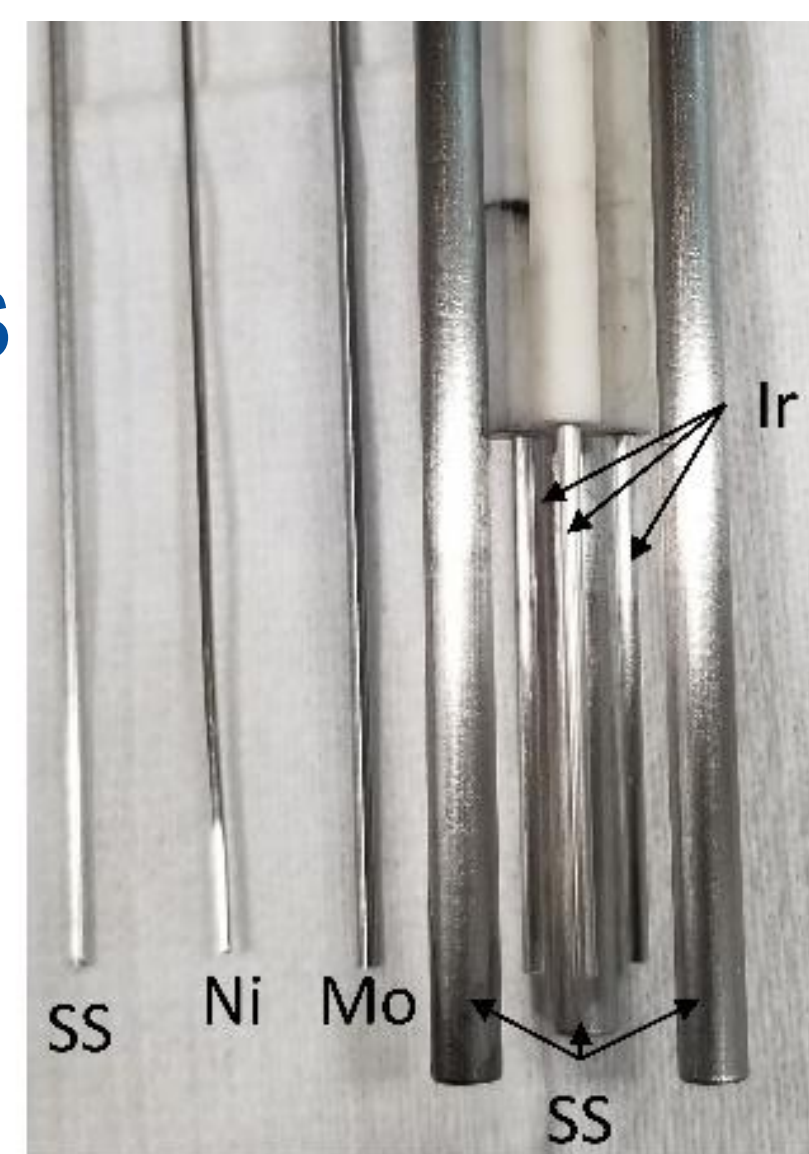


Fig. 1: Pyrochemical fuel recycling unit operations including process monitoring equipment.

Initial Testing

- Lab-scale tests to explore materials
- Tested different reference/pseudo electrodes
 - Nickle (Ni) wire, iridium (Ir) wire, Ni/NiO
- Tested different working & counter electrodes
 - Tungsten (W), moly (Mo), Ir, stainless steel (SS),
- Results: SS and Ir best electrodes with Ir and/or Ni/NiO reference electrodes (RE), see Fig 2



Lab-scale electrodes

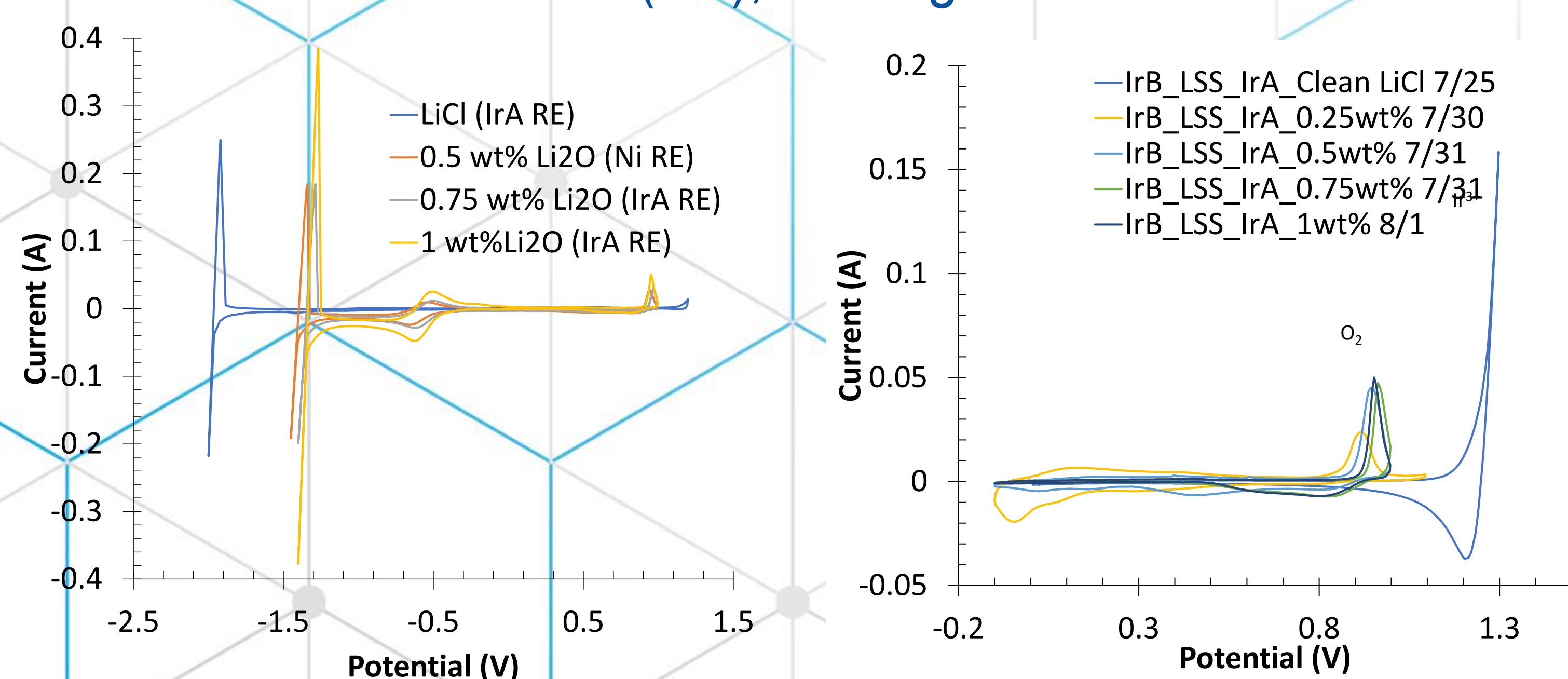


Fig. 2: CVs with Ir as working electrode and SS as counter electrodes.

Results

- Testing in the OR furnace during used fuel reprocessing demonstrations were performed with an OR Sensor containing a SS and Ir WE with a Ni/NiO RE
- Result showed good tracking capability for OR salt
- However, the electrodes were not well protected and easily damaged

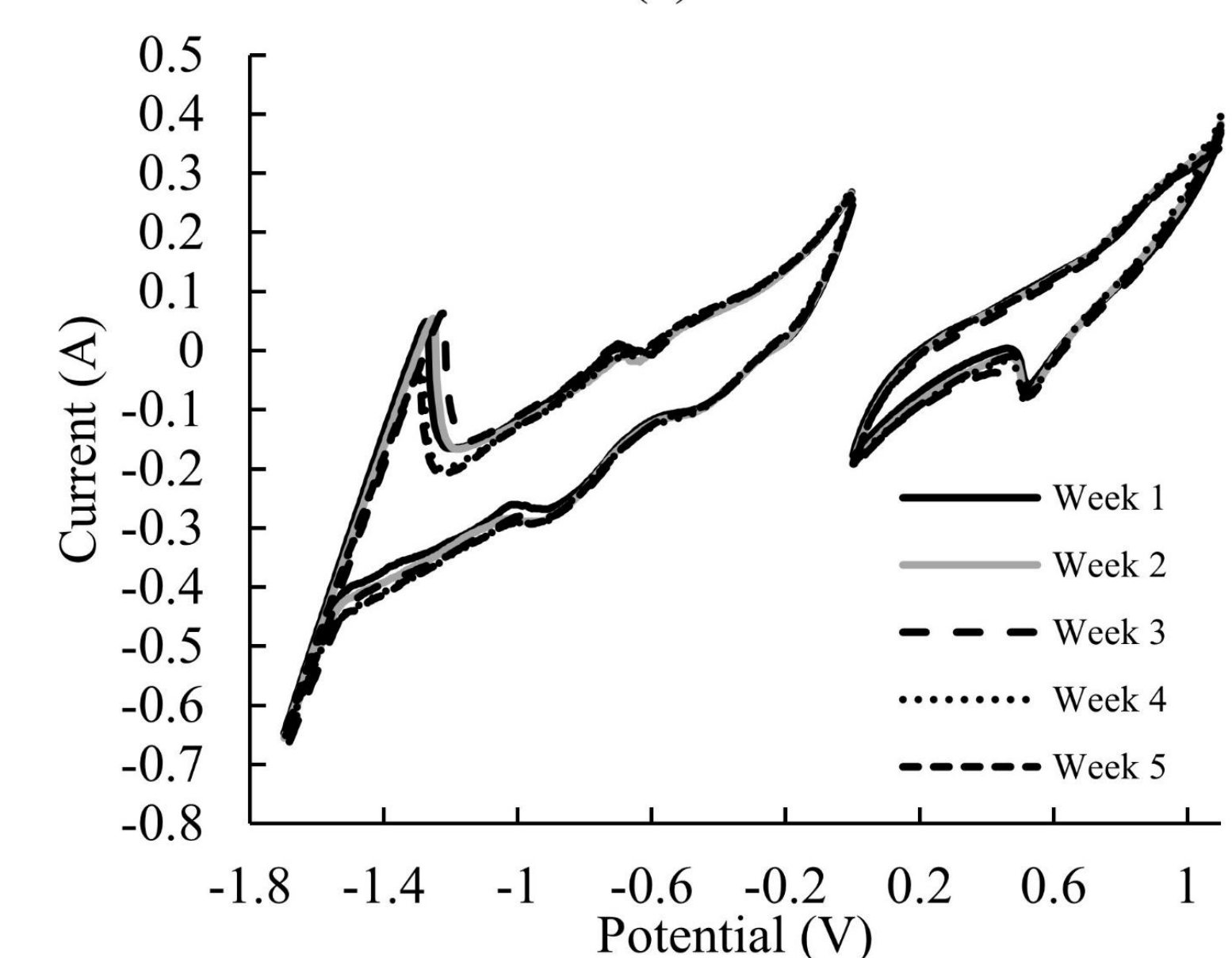
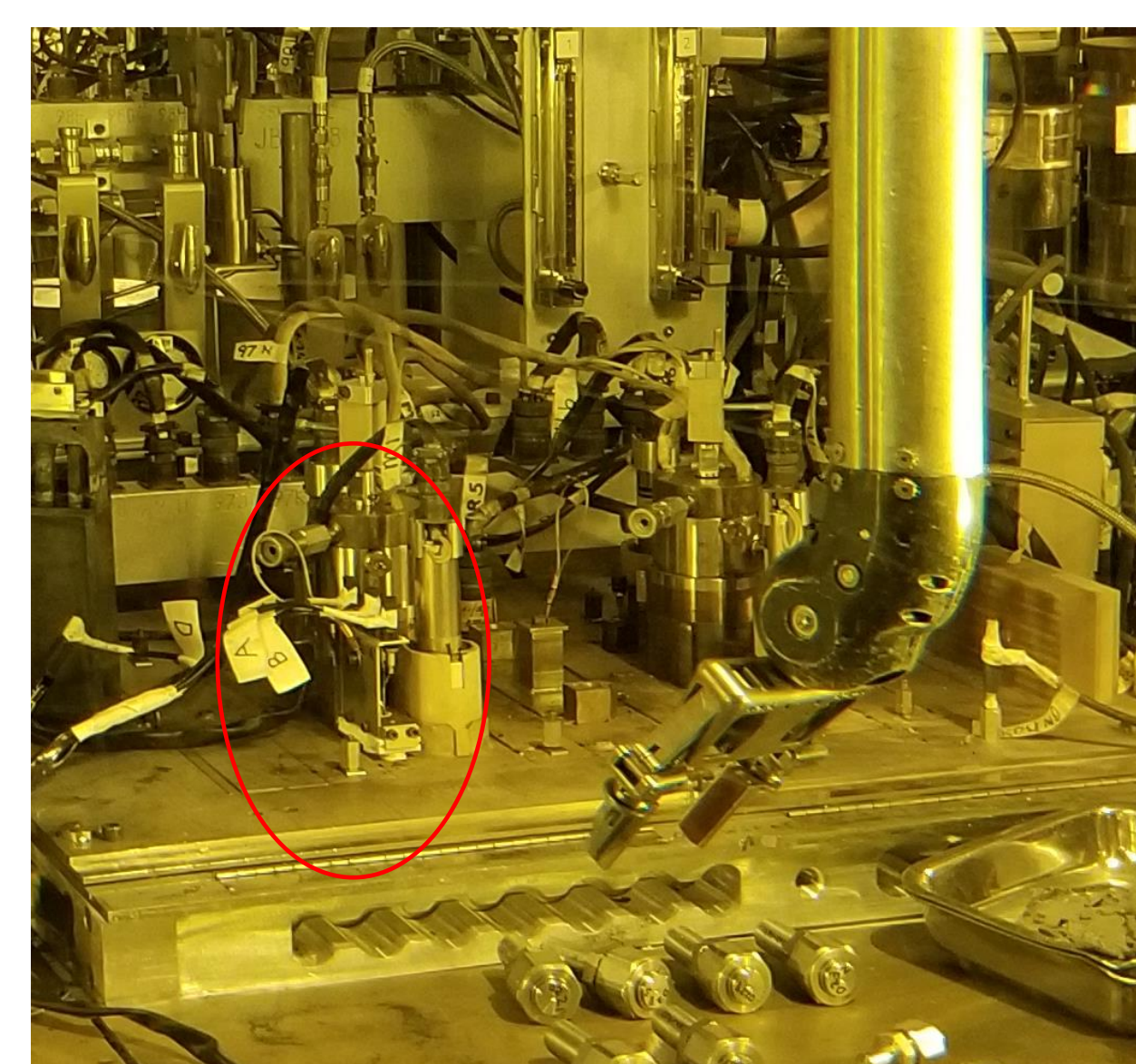


Fig. 3: OR voltammetry sensor (top), Location of voltammetry sensor in OR furnace during fuel reprocessing demonstrations (bottom, left), and CVs from OR sensor testing (bottom, right).

New Sensor Design

- Designed a new sensor utilizing initial testing data and field-testing experience
- Three central Ir electrodes surrounded by three SS counter electrodes

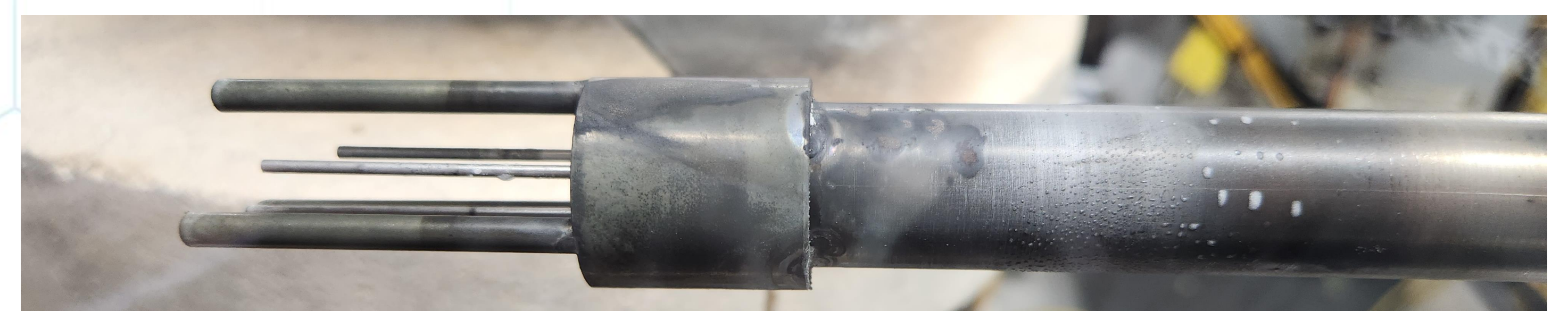


Fig. 4: New OR voltammetry sensor design with protective SS counter electrodes surrounding three Ir electrodes

Next Steps

- Test the new sensor in HFEF!
- Bridge the gap between laboratory and field results.
 - Moisture/oxygen content
- Further identify and optimize cleaning and rest procedures between cyclic voltammetry (CV) scans

Acknowledgments

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